THE COMPARATIVE VALUE OF DEMONSTRATION IN CHILD AND ADULT LEARNING IN PROBLEM SITUATIONS

by

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TABLE OF CONTENTS

Page

PROBLEM.. 1

MATERIALS AND METHODS............................ 1

REVIEW OF LITERATURE............................. 4

RESULTS AND INTERPRETATIONS...................... 7

CONCLUSIONS...................................... 27

ACKNOWLEDGMENTS.................................. 29

LITERATURE CITED................................. 30

PROBLEM

The purpose of this study was to find the comparative effects of demonstration in problem solving on the performance of children and of adults.

MATERIALS AND METHODS

Eighty male students served as subjects for this experiment. Forty of these were adults taken from the psychology classes of Kansas State College, and 40 were boys from the sixth and seventh grades of the public schools of Manhattan. Adults were selected from the upper 50 per cent in intelligence as measured by the college freshman tests. Seventh grade students were chosen from the highest one-third in intelligence as measured by the McCall Multi-Mental Test of Mental Ability. Sixth grade students were chosen in the same manner by means of the Hennon-Nelson Test of Mental Ability. It was thought that by limiting the intelligence level to the highest one-third in the case of children, and to the upper one-half in the case of adults, the groups would be at least roughly comparable. Adult control and demonstration groups each consisted of 20 individuals. Child control and demonstration groups each consisted of the same number of subjects, 12 of whom were sixth grade students and 8 of whom were seventh grade students. The average age of the sixth grade subjects was approximately 11½ years, and that of the seventh grade group, 12½ years.

The problem to be solved by subjects in this study was essentially a game which required a considerable amount of thought and analysis for solution. It was so designed that a series of problems of increasing difficulty was presented to the subjects. Throughout the series, there was a general principle involved, which gradually came to be recognized and made use of by the subject.

The apparatus consisted of a small board approximately 11 inches long and 5 inches wide, marked off from left to right into 11 adjacent zones labelled A, F, M, U, X, O, 1, 2, 3, 4, 5. Movable discs, colored and labelled so that one corresponded to each zone except the middle zone, O, were used in playing the game. In the beginning, discs 1 and 2 were placed on the board beneath positions U and X, and discs U and X were placed beneath positions 1 and 2. Subjects were required to move the discs across the middle zone to positions corresponding to the labels on the discs, making only such moves as were allowed by directions previously given to the student. This constituted the simplest problem of a series. When it had been solved without erroneous moves in 3 successive trials, another disc was added at each side of the middle zone, making a second problem of greater difficulty. Another disc was added at each side for the third problem, and still another for the fourth problem. Thus the number of discs to be moved each way was 2 in the first problem (A), 3 in the second problem (B), 4 in the third (C), and 5 in the fourth (D).

Subjects were taken individually into a quiet well-lighted room. The following directions were read with appropriate illustrations and could be referred to at any time by the subjects:

"The object of the game is to move these blue discs over to spaces having the same numbers that the discs have, and to move these red discs to their proper places. You may make two kinds of moves -- either slide one space at a time, or jump one disc of the opposite color. Red discs must be moved toward the red part of the board and blue ones toward the blue part -- they cannot be moved backward. Only one disc can be jumped in any one move. Think before each move. As soon as you can see that you are not going to win, say 'Stop,' and we will start over, regardless of whether you really could have won or not. Please call your moves out loud like this: 'One on zero, two on A,' etc. Always start with the disc which is below the space, number 1."

The procedure was the same in all cases except that a demonstration at the close of each unsuccessful trial was given to members of the experimental groups, but was not given to members of the control groups. Since, in a preliminary study, demonstration seemingly had little effect, an attempt was made in this study to make demonstration more effective. This was done by the experimenter giving more time to each move while demonstrating, and by pausing with the hand poised over the wrong disc where a critical move was to be made, before finally selecting the proper disc to be moved. The pause (approximately 6 seconds) for emphasis of critical moves was nearly three times as long as the period of time (approximately 2½ seconds) between ordinary moves. Thus attention was directed to critical points where erroneous moves were likely to be made.

A careful record was kept of the following points for each problem: time consumed in each trial (and in each move which required 5 seconds or more), number of trials required, number of errors made, number of moves made after making an error before the subject realized that an error had been made, and time consumed after error before realization of error. Time, in seconds, was taken by means of a stop watch.

REVIEW OF LITERATURE

Few studies have been made of the problem-solving abilities of children. Perhaps this has been due to the rather prevalent belief that children would not make fit subjects because of their alleged inability to reason. Such a belief apparently has little to support it, as has been shown in several studies. An experiment by Bonser (1) indicates that there is comparatively little difference between the reasoning ability of a child of 8 and that of a youth. Similarly, in a study by Peterson (6) a child of 11 made a very creditable showing among a group of college graduate men, in solving problems which involved abstract thinking. Children then, may well be used as subjects in studies of problem solving.

The use of puzzles in making such studies dates back to the work of Lindley (5) in 1897. They have been used since in a number of investigations such as those of Ruger (7), Peterson (6), and Waters (8). Ruger's and Peterson's studies were concerned mainly with analysis of the learning processes. Waters attempted to compare the effectiveness of various methods of tuition in problem solving, and in transfer to subsequent similar problems. He found that the demonstration method of guidance was detrimental in its effect upon problem solving and upon transfer. For the solving of immediate problems, the order of decreasing effectiveness of the various methods used was instruction method (giving instruction as to principles involved), error method (notifying the subject of error, and requiring immediate correction), and attention method (directing attention to significant aspects of the problem). For effectiveness in transfer, the order became attention method, and instruction method. The error method had no effect.

A study of the effects of visual guidance on maze learning has been made by Carr (2), and one on the effects of verbal guidance in maze learning, by Ewert and Lambert (4). These studies in maze learning are somewhat different from problems in puzzle solving. They are related to the present study, however, in that they involve guidance by intellectual means, in the learning process.

In the experiment conducted by the writer, learning was of the problem-solving type. The guidance method used was one which, on the basis of Waters' classification, might perhaps be described as a combination of the demonstration and the attention methods; that is, demonstrations were given in such a manner that attention was directed to significant aspects of the problem. The present study differs from any of those referred to above in that an attempt was made by the writer to compare child groups with adult groups in the effects produced by demonstration in learning of the problem-solving type.

During the fall semester of the college year 1936-37 the writer conducted a preliminary experiment, using methods similar to those employed in the present study. Due to the fact that few cases were used, and that conditions under which the subjects worked varied considerably, the results were inconclusive. It was decided, therefore, to repeat the experiment, employing more careful controls and a larger number of subjects.

RESULTS AND INTERPRETATIONS

Before presenting the data, it is necessary to explain briefly the units of measurement used. Success in solving the problems was measured in terms of time consumed, trials required, errors made, moves made after error before the subject realized his error, and time consumed after error before the subject realized his inability to win. Time consumed was measured in seconds and requires no explanation. A move responsible for the subject's failure to win in a given trial constituted an error. Thus by definition only one error could be made in each trial. A series of moves which culminated in success or in failure to win, constituted a trial. After an error had been made in a given trial, it was still possible for the subject to make additional moves (called extra moves in the records) before he finally realized it was impossible to win in that trial. The number of such moves made by an individual may be considered a measure of the subject's ability to recognize errors when made or a measure of the degree of learning achieved. Similarly, the time consumed after error (called extra time in the records) serves to indicate the subject's degree of mastery of the problem, by revealing the readiness with which he recognizes errors made.

It was noted in this study that in problem A, comparatively little time and few trials were required, and few errors were made. This was because fewer moves were involved than in any other problem, hence there were fewer opportunities for error, and it was much easier to foresee the consequences of a move in a perceptual manner. In later problems, perceptual solutions were much more difficult if not impossible, so analysis and generalization became necessary.

Random manipulation or attempts at trial and error learning occurred in early trials of these more difficult problems, and to some extent, perhaps, throughout the series. Gradually, however, this tendency gave way to more careful analysis.

Accidental successes frequently followed expressed expectation of failure. It often happened that a subject, after many unsuccessful trials would say, "I know this move is not right but I might as well try it." He would then make the correct move which would enable him to go on and win. It has been noted by Peterson (6, p. 57-59) that such accidental successes occurring in early trials of a problem were usually followed by failure to recall. Many cases in this study offer evidence to support his statement. For example, subject 5c, a member of the child control group, achieved his first success in problem B in the twelfth trial (which for him was an early trial). He then required 27 additional trials before he was able to win again. On the other hand, as has also been shown by Peterson (6, p. 59), success occurring in later trials of a problem is more apt to be followed by repeated success. The record of subject 9c, a member of the child control group, illustrates this point nicely. This subject required 29 trials to achieve his first solution of problem B. He then made one error, after which he succeeded in the 3 attempts which followed. The facts mentioned above may well be explained by quoting statements made by Cleveland (3, p. 297) in a study published as long ago as 1907. At that time he said, "The learning process involves the progressive organization of knowledge.....How (this) organization can best be brought about is still an open question.....To a great extent the material organizes itself; that is, organization is physiological and a matter of growth."

Records of subjects yield evidence that those who required little time and few trials in solving problem A made comparatively poorer records than might have been expected of them in solving later problems. The explanation lies in the fact that solution of problem A was accomplished quickly in a perceptual manner by those subjects. They, therefore, spent so little time and required so few trials in solving problem A that they gained little knowledge of the principle involved -- knowledge which would have enabled them to generalize and to succeed more easily in later problems. Other students who found problem A more difficult tended to do better in later trials because, for them, solution of problem A had resulted in a sufficient degree of learning to enable generalization to become more effective.

In considering the effects of demonstration, some very interesting results were obtained. Comparative performances of paired groups in the entire learning problem are presented in Tables 1 and 2. In the first line of Table 1, it may be seen in columns 2, 3, and 4, that the adult control group (subscript 1) required a mean time of 1480.75 seconds, with a standard deviation of distribution of 623.5, and a standard error of the mean of 139.42. The adult demonstration group (subscript 2) required a mean of 962.5 seconds, with a standard deviation of distribution of 330.34, and a standard error of the mean of 73.87. The differences between means for the adult control and demonstration groups was 518.25 seconds, with a standard error of the differences of 157.78. The critical ratio was 3.28, which is statistically significant. The first line of Table 2 similarly reveals the same features of performance of child groups. Succeeding lines in these 2 tables describe or present in similar manner the same facts concerning trials required (Tr), errors made (Err),

Table 1. Mean performance of adult groups in total time required, total errors made, total number of trials required, time consumed after error, and number of moves made after error in all problems combined.

	M_1	S. D. Distribution 1	S. E. M_1	M_2	S. D. Distribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
T	1480.75	623.5	139.42	962.5	330.34	73.87	518.25	157.78	3.28
Tr	25.4	8.11	1.81	21.5	2.66	.593	3.9	1.91	2.04
Err	10.7	7.14	1.62	7.	2.	.447	3.7	1.68	2.20
EM	25.8	19.16	4.28	17.1	15.67	3.51	8.7	5.52	1.58
ET	266.	20.41	4.58	123.	82.99	18.56	143.	19.12	7.48

In Tables 1 and 2, subscript 1 signifies control group and subscript 2 signifies demonstration group. T signifies time in seconds; Tr, trials; Err, errors; EM, moves made after error before realization of error; and ET, seconds consumed after error before realization of error.

Table 2. Mean performance of child groups in total time required, total errors made, total number of trials required, extra time consumed after error, and number of moves made after error in all problems combined.

	M_1	S. D. Distribution 1	S. E. M_1	M_2	S. D. Distribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
T	2675.	1218.5	272.47	1196.25	386.4	86.40	1478.75	285.67	5.18
Tr	47.75	21.30	4.76	28.1	6.34	1.42	19.65	4.97	3.96
Err	30.	19.18	4.29	12.4	6.78	1.52	17.6	4.55	3.87
EM	83.25	51.80	11.58	33.25	21.46	4.80	50.	12.54	3.99
ET	630.	480.2	107.38	170.	93.06	20.81	460.	109.38	4.21

Table 3. Mean number of seconds required by adult groups in solving problems A, B, C, and D.

Problem	M_1	S. D. Distribution 1	S. E. M_1	M_2	S. D. Distribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
A	219.95	252.79	56.53	124.05	53.51	1.19	95.9	56.54	1.696
B	454.25	222.17	49.68	241.85	123.74	27.67	212.4	56.87	3.735
C	438.50	300.83	67.28	303.45	150.08	33.56	135.05	75.19	2.461
D	322.80	170.27	38.07	293.5	117.99	26.33	29.3	46.32	.632

In Tables 3 to 12, subscript 1 signifies control group and subscript 2 signifies demonstration group; Problem a involves transfer of two discs each way; Problem B involves transfer of three discs each way; Problem C involves transfer of four discs and Problem D, 5.

Table 4. Mean number of seconds required by child groups in solving problems A, B, C, and D.

Problem	M_1	S. D. Distribution 1	S. E. M_1	M_2	S. D. Distribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
A	350.75	233.12	53.25	169.45	95.69	21.40	131.3	57.38	3.16
B	959.85	551.34	123.29	257.55	125.82	28.14	702.3	126.46	5.55
C	815.45	614.53	137.42	387.35	164.35	36.75	428.1	142.25	3.01
D	554.45	602.67	134.76	389.25	141.72	31.69	165.2	133.71	1.19

Table 5. Mean number of trials required by adult groups in solving each problem.

Prob-lem	M_1	S. D. Dis-tribution 1	S. E. M_1	M_2	S. D. Dis-tribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
A	5.9	3.62	.569	5.55	2.04	.455	.35	.729	.480
B	8.14	3.42	.809	5.45	1.59	.356	2.69	.885	3.04
C	6.8	2.33	.765	6.05	2.54	.568	.75	.952	.787
D	4.55	2.04	.522	4.45	1.66	.371	.10	.640	.156

Table 6. Mean number of trials required by child groups in solving each problem.

Prob-lem	M_1	S. D. Dis-tribution 1	S. E. M_1	M_2	S. D. Dis-tribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
A	9.85	7.45	1.66	6.15	2.01	.448	3.7	1.72	2.14
B	13.9	10.14	2.27	7.35	3.88	.939	11.55	2.44	4.74
C	11.7	7.44	1.66	7.35	5.62	.509	3.35	1.55	2.03
D	7.5	4.51	1.01	6.15	2.15	.481	1.35	1.12	1.21

Table 7. Mean number of errors made by adult groups in solving each problem.

Problem	M_1	S. D. Distribution 1	S. E. M_1	M_2	S. D. Distribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
A	2.15	1.93	.432	1.65	1.11	.248	0.50	.497	1.01
B	4.15	3.21	.717	2.05	1.13	.264	2.10	.764	2.75
C	3.3	2.79	.625	2.3	1.32	.407	1.0	.746	1.34
D	.95	1.56	.349	1.0	1.05	.236	-.05	.421	-.12

Table 8. Mean number of errors made by child groups in solving each problem.

Problem	M_1	S. D. Distribution 1	S. E. M_1	M_2	S. D. Distribution 2	S. E. M_2	M_1-M_2	S. E. $(M_1-M_2$	C. R.
A	5.25	6.99	1.56	2.35	1.46	.326	2.90	1.59	1.82
B	14.45	10.44	2.33	3.8	3.34	.746	10.65	2.45	4.35
C	7.25	6.54	1.46	3.6	2.22	.497	3.65	1.54	2.36
D	2.85	2.80	.627	2.3	1.68	.375	.55	.724	.76

Table 9. Mean number of extra moves made by adult groups before realization of error.

Prob-lem	M_1	S. D. Distribution 1	S. E. M_1	M_2	S. D. Distribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
A	4.9	5.41	1.21	3.5	2.75	.615	1.4	1.36	1.03
B	11.1	8.73	1.95	4.65	2.90	.649	6.45	2.06	3.14
C	7.4	6.50	1.45	5.25	5.30	1.18	2.15	1.88	1.15
D	2.3	4.46	.997	3.15	3.70	.826	-.85	1.30	-.66

Table 10. Mean number of extra moves made by child groups before realization of error.

Prob-lem	M_1	S. D. Distribution 1	S. E. M_1	M_2	S. D. Distribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
A	12.3	15.09	3.38	4.65	3.13	.701	7.65	3.30	2.32
B	40.05	35.49	7.94	10.3	9.46	2.12	29.75	8.21	3.62
C	22.4	27.93	6.25	9.45	8.07	1.80	12.95	6.50	1.99
D	8.2	12.12	2.71	8.35	9.61	2.15	-.15	3.46	-.04

Table 11. Mean number of seconds required after error by adult groups before realization of error.

Problem	M_1	S. D. Distribution 1	S. E. M_1	M_2	S. D. Distribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
A	68.9	74.02	16.55	26.9	25.19	5.63	42.0	17.43	2.40
B	110.0	80.66	18.04	37.65	50.22	11.23	72.35	21.25	3.40
C	72.4	91.08	20.36	45.4	53.52	13.09	27.0	24.21	1.12
D	11.25	18.42	4.12	12.45	15.99	3.58	-1.2	5.45	-.220

Table 12. Mean number of seconds required after error before realization of error by child groups.

Problem	M_1	S. D. Distribution 1	S. E. M_1	M_2	S. D. Distribution 2	S. E. M_2	M_1-M_2	S. E. (M_1-M_2)	C. R.
A	104.9	99.25	22.19	33.7	25.81	5.77	66.2	22.93	2.89
B	293.	239.27	53.50	53.6	45.93	10.27	239.35	54.48	4.39
C	175.2	225.27	50.37	49.1	37.98	8.49	126.1	51.09	2.47
D	49.05	67.49	15.09	25.0	28.00	6.26	24.05	16.34	1.47

Table 13. Mean performance of adult and child control groups in total time required, total number of trials, total number of errors, extra moves after error and time consumed after error.

	M_c	S. D. Distribution c	S. E. M_c	M_a	S. D. Distribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C. R.
T	2675.	1218.5	272.47	1480.75	623.5	139.42	1194.25	306.07	3.90
Tr	47.75	21.30	4.76	25.4	8.11	1.81	22.35	5.09	4.39
Err	30.	19.18	4.29	10.7	7.14	1.62	19.3	4.47	4.32
EM	83.25	51.30	11.58	25.8	19.16	4.28	57.45	12.35	4.65
ET	630.	430.2	107.38	266.	20.41	4.58	364.	107.48	3.39

In Tables 13 to 24, subscript c signifies child group and subscript a signifies adult group.

Table 14. Mean performance of adult and child demonstration groups in total time required, total number of trials, total number or errors, extra moves after error and time consumed after error.

	M_c	S. D. Distribution c	S. E. M_c	M_a	S. D. Distribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C. R.
T	1196.25	386.4	86.40	962.5	330.34	73.87	233.75	113.67	2.06
Tr	28.1	6.34	1.42	21.5	2.66	.593	6.6	1.54	4.30
Err	12.4	6.78	1.52	7.	2.	.447	8.7	1.58	5.50
EM	33.25	21.46	4.80	17.1	15.67	3.51	16.15	5.94	2.72
ET	170.	93.06	20.81	123.	82.99	18.56	47.	27.86	1.69

Table 15. Mean number of seconds required by adult and child control groups to solve problems A, B, C, and D.

Problem	M_c	S. D. Distribution c	S. E. M_c	M_a	S. D. Distribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C. R.
A	350.75	233.12	53.25	219.95	252.79	56.53	130.8	77.66	1.68
B	959.85	551.34	123.29	454.25	222.17	49.68	505.6	199.70	2.53
C	815.45	614.53	137.42	488.50	300.83	67.28	326.9	153.00	2.13
D	554.45	602.67	134.76	322.80	170.27	38.07	231.6	140.04	1.65

Table 16. Mean number of seconds required by adult and child demonstration groups to solve each problem.

Problem	M_c	S. D. Distribution c	S. E. M_c	M_a	S. D. Distribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C.R.
A	169.45	95.69	21.4	124.05	53.51	1.19	45.4	21.43	2.12
B	257.55	125.32	28.14	241.85	123.74	27.67	15.7	38.17	.41
C	387.35	164.35	36.75	303.45	150.08	33.56	83.9	99.77	.84
D	339.25	141.72	31.69	293.5	117.99	26.38	95.8	41.24	2.32

Table 17. Mean number of trials required by adult and child control groups to solve each problem.

Problem	M_c	S. L. Distribution c	S. E. M_c	M_a	S. L. Distribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C. R.
A	9.85	7.45	1.66	5.9	3.62	.569	3.95	1.76	2.24
B	18.9	10.14	2.27	8.14	3.42	.809	10.76	2.41	4.47
C	11.7	7.44	1.66	6.8	2.33	.765	4.9	1.83	2.68
D	7.5	4.51	1.01	4.55	2.04	.522	2.95	1.14	2.60

Table 18. Mean number of trials required by adult and child demonstration groups to solve each problem.

Problem	M_c	S. D. Distribution c	S. E. M_c	M_a	S. D. Distribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C. R.
A	6.15	2.01	.448	5.55	2.04	.455	.60	.639	.94
B	7.35	3.98	.389	5.45	1.59	.356	1.90	.953	1.99
C	7.85	3.62	.809	6.05	2.54	.568	1.80	.984	1.83
D	6.15	2.15	.481	4.45	1.66	.371	1.70	.607	2.80

Table 19. Mean number of errors made by adult and child control groups in solving each problem.

Problem	M_c	S. D. Distribution c	S. E. M_c	M_a	S. D. Distribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C. R.
A	5.25	6.99	1.56	2.15	1.93	.432	3.10	1.62	1.91
B	14.45	10.44	2.33	4.15	3.21	.717	10.30	2.44	4.22
C	7.25	6.54	1.46	3.3	2.79	.625	3.95	1.59	2.48
D	2.85	2.80	.627	.95	1.56	.349	1.90	.718	2.64

Table 20. Mean number of errors made by adult and child demonstration groups in solving each problem.

Problem	M_c	S. D. Distribution c	S. E. M_c	M_a	S. D. Distribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C. R.
A	2.35	1.46	.326	1.65	1.11	.248	.70	.410	1.71
B	3.8	3.34	.746	2.05	1.18	.264	1.75	.791	2.21
C	3.6	2.22	.497	2.3	1.82	.407	1.3	.642	2.02
D	2.3	1.68	.375	1.0	1.05	.236	1.3	.442	2.94

Table 21. Mean number of extra moves made by adult and child control groups before realization of error.

Prob-lem	M_c	S. D. Dis-tribution c	S. E. M_c	M_a	S. D. Dis-tribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C. R.
A	12.3	15.09	3.38	4.9	5.41	1.21	7.4	3.58	2.06
B	40.05	35.49	7.94	11.1	8.73	1.95	28.95	8.17	3.54
C	22.4	27.93	6.25	7.4	6.50	1.45	15.0	6.41	2.34
D	8.2	12.12	2.71	2.3	4.46	.997	5.9	2.89	2.04

Table 22. Mean number of extra moves made by adult and child demonstration groups before realization of error.

Prob-lem	M_c	S. D. Dis-tribution c	S. E. M_c	M_a	S. D. Dis-tribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C. R.
A	4.65	3.13	.701	3.5	2.75	.615	1.15	.295	3.90
B	10.3	9.46	2.12	4.65	2.90	.649	5.65	2.21	2.55
C	9.45	8.07	1.80	5.25	5.30	1.18	4.20	2.16	1.94
D	8.35	9.61	2.15	3.15	3.70	.826	5.20	2.30	2.26

Table 23. Mean number of seconds required after error, by adult and child control groups, before realization of error.

Problem	M_c	S. D. Distribution c	S. E. M_c	M_a	S. D. Distribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C. R.
A	104.9	99.25	22.19	68.9	74.02	16.55	36.0	27.69	1.30
B	293.0	239.27	53.50	110.0	80.66	18.04	183.0	56.46	3.24
C	175.2	225.27	50.37	72.4	91.08	20.36	102.8	54.34	1.89
D	49.05	67.49	15.09	11.25	18.42	4.12	37.8	15.64	2.41

Table 24. Mean number of seconds required by adult and child demonstration groups after error, before realization of error.

Problem	M_c	S. D. Distribution c	S. E. M_c	M_a	S. D. Distribution a	S. E. M_a	M_c-M_a	S. E. (M_c-M_a)	C.R.
A	38.7	25.81	5.77	26.9	25.19	5.63	11.8	8.06	1.46
B	53.6	45.93	10.27	37.65	50.22	11.23	16.0	15.22	1.05
C	49.1	37.98	8.49	45.4	58.52	13.09	3.7	15.60	.237
D	25.0	23.00	6.26	12.45	15.99	3.58	12.6	7.21	1.74

moves made after error before realization of error (EM), and time consumed after error before realization of error (ET). In tables where subscripts other than 1 and 2 are used, subscript c signifies child group and subscript a signifies adult group.

In comparing the child demonstration and control groups, it is evident from Table 2 that demonstration here resulted in a reduction or saving which is significant in all measures used; namely, time, trials, errors, extra moves, and extra time.

As compared with the adult control group, the adult demonstration group showed no significant saving in trials required, errors made, or number of erroneous moves made before realization of error. The saving was significant in time required for solution, and in time spent after error before realization of error. Referring to Tables 3, 5, 7, 9, and 11, it may readily be observed that in each measure of performance, wherever the adult demonstration group is superior to the adult control group, the significant difference is found in problem B, and not in the other 3 problems. This would seem to indicate that problem A was simple for adults, and that perceptual learning took place just about as readily in the control group as in the demonstration group. Problem B presented real difficulty, however, and here the value of demonstration made its appearance. After solving problem B, which was sufficiently long and difficult to bring about a fairly thorough understanding of the nature of the solution, the subjects found less difficulty with later problems although such problems really are inherently more difficult. Apparently, this facilitation was due to transfer. There is no experimental evidence to uphold this assumption, but it is the only rational explanation.

In comparing the performance of the child demonstration group with the child control group (see Tables 4, 6, 8, 10, and 12), significant differences in each measure were likewise found in problem B and not in the other problems, although there was an approach to significance in problem A. This may be explained as above. One exception was in the measure of time (Table 4). Here significant differences occurred in problems A, B, and C. This indicates that problem A was also difficult for children, hence demonstration was of more value in A for children than it was for adults. This loss in significant differences may, however, be the result of the increasing simplicity of successive problems for the adult group. The simplicity may have prevented the capacities of the brighter individuals from functioning fully in these problems and thus reduced the variability within the group and the magnitude of the difference between the two groups. The same simplification may have resulted in something of the same skewness in the children's performance but to a much smaller degree. Also the degree of transfer in problem C appears to be less for children than for adults. This is what would be expected in view of the fact that children depended more upon perception for learning in earlier problems. That perceptual learning transfers less than conceptual learning in a somewhat similar problem situation was shown by Peterson (6). Hence problem C was more difficult for them, and demonstration was of greater value.

It is shown in Table 13 that the adult control group consistently surpassed the child control group in all measures of performance. The difference was significant in each of the 5 measures used.

The differences in performance between the adult and child demonstration groups were not so consistent. The difference was significant in errors made, and in trials required, but not in the other 3 measures of performance. This is shown clearly in Table 14.

It is evident (from Tables 15, 17, 19, 21 and 23) that wherever the adult control group is significantly superior to the child control group, this superiority is shown in problem B and in no other problems. It is also apparent (in Tables 16, 18, 20, 22, and 24) that no significant differences exist, in individual problems, between the performance of adult and child demonstration groups except in the measure of extra moves made after error but before realization of error, in problem A. This exception may be explained on the basis of statements previously made indicating that problem A presented greater difficulty to children than to adults.

Children moved somewhat faster than adults, thus more nearly matching the pace of the experimenter's demonstrations. It was thought that this might possibly have contributed to the superiority of the child group in the matter of profiting from demonstration. A more careful comparison, however, of speed of movement with errors revealed that this difference was not statistically significant. The mean time per move for the child control group was 3.35 seconds and the mean number of errors made was 30. The correlation between these two variables was .458, with a probable error of correlation of .119. For the child demonstration group the mean time per move was 2.91 seconds, the mean number of errors, 12.4, and the correlation between speed of movement and number of errors made was -.226 ± .143. The adult control group moved at an average speed of 3.98 seconds per move. The mean number of errors was 10.7, and the correlation, .094 ± .149. In the case of the adult demonstration group, the mean time per move was 2.92 seconds, the mean number of errors, 7, and the correlation, .312 ± 1.36. Thus it may be seen that although demonstration reduced the time per move and the number of errors made, the correlation between speed of movement and number of errors made, for the different groups, is so low and the probable errors are so high, comparatively, that we may say the slight superiority of children in speed of movement made little or no contribution to their superiority in profiting from demonstration.

CONCLUSIONS

1. In general, the demonstrations were more helpful to children than to adults when results were measured in terms of total time and total trials required, of total errors made, or of extra moves made before realization of error, in solving the problems.

2. When the influence of demonstration was measured in terms of time required to recognize erroneous moves, the adult learners profited most by demonstrations.

3. Without demonstration, adults show a significant superiority over children in performance as measured by all the different criteria, but with demonstrations this superiority loses its statistical significance when performance is measured in terms of total time required, or of moves made or time consumed after the occurrence of an error.

4. To what extent these generalizations will hold for groups of child and adult subjects chosen from levels of intelligence other than those here represented, or working

upon other problems or using other modes of demonstration, cannot be predicted from the results of this study.

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